

WIJNGAARDEN, A. VAN (1959): De zoogdieren van Noord-Beveland; De Levende Natuur 62. Ders. (1963): Het eerste muizenreservaat in Nederland; Lutra 5:41—42.

Anschriften der Verfasser: Dr. A. VAN WIJNGAARDEN, L. v. Beek en Royen 40—41, Zeist, Nederlande, und Prof. Dr. KLAUS ZIMMERMANN, Berlin N 4, Invalidenstrasse 43

Some observations on body flexibility of bottle-nosed dolphins, *Tursiops truncatus*, in captivity

By FRANK S. ESSAPIAN

Eingang des Ms. 19. 6. 1964

Small delphinids have been noted for their graceful movements in water and for their ability to execute most difficult maneuvers, including high leaps out of water. Those who have had an opportunity to observe these animals at close range, as in marine

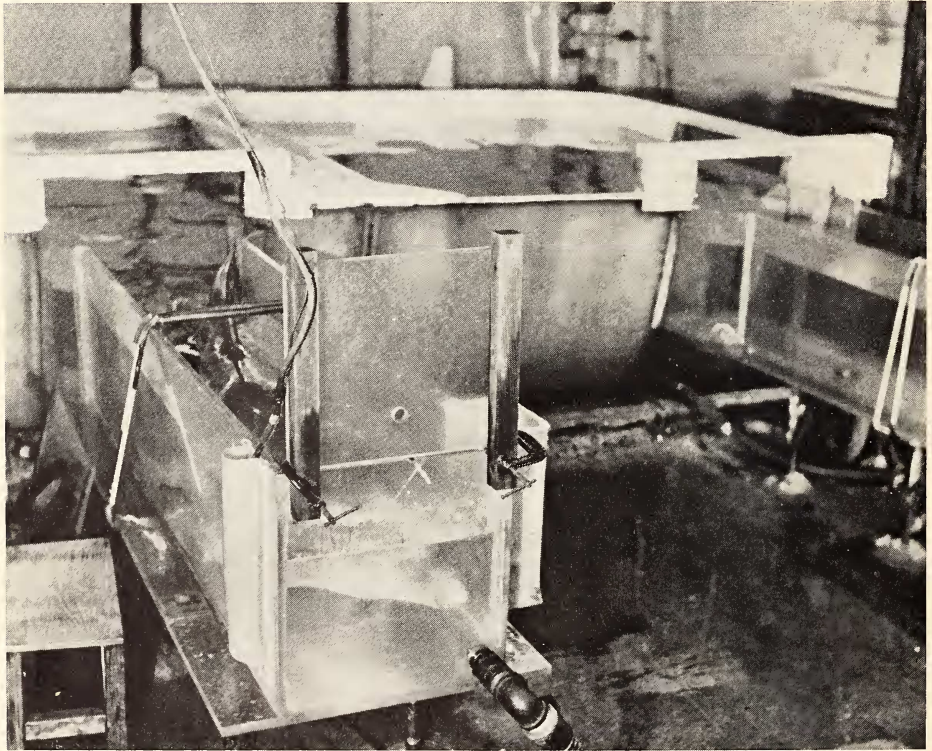


Fig. 1. Elvar and Chee Chee are the occupants of two separate 7 ft. x 9 ft. fiberglass pools shown in the background. The partition which divides the two pools is furnished with a gate. Elvar had moved into his plexiglass "sidearm" tank, in the foreground, is watching the photographer

aquariums, have often marvelled at the pliancy of their bodies and at the powerful musculature with which these animals are endowed.

It is intended to describe here the behavior of bottle-nosed dolphins, *Tursiops truncatus* which, while held in conditions of complete or partial intra-species isolation, developed spontaneously a series of body flexions. In the absence of conventional limbs, they utilized other parts of their bodies in a most unusual manner.

The animals in question were kept at the Miami, Florida, laboratory of the Communication Research Institute for experimental purposes. They were not trained to perform tricks or others circus acts. A number of "toys" made out of rubber, styro-foam, and other plastic materials were made available to the animals. There was no interference with the animals' choice of play patterns which, in some instances, assumed a form of physical exercise.

One of the animals, Elvar, a male, was estimated to be 3 to 4 years old at the time of observations in late 1961–62. He was captured in the Florida Keys in July, 1960 (LILLY, 1961). He was kept in a fiberglass pool approximately seven feet by nine feet, and 36 inches deep. The level of circulating sea-water was maintained at about 27 inches. He was separated by a wooden partition from another dolphin Chee Chee, an adult female estimated to be from 12 to 14 years of age, at the time of observations, who occupied a pool of similar dimensions alongside Elvar's. She was captured on 9 May, 1961. The partition was provided with a gate which, when opened, enabled the animals to join one another during the weekend. On weekdays, the animals could see one another by raising themselves above the partition, or by swimming into the special oblong plexiglass "sidearm" tanks approximately eight feet long, 24 inches high, and 24 inches wide (Fig. 1). Two of these tanks were attached to the animals' pools in a parallel fashion and were accessible to the animals at all times. The animals were also able to communicate with one another by exchange of sounds (LILLY & MILLER, 1961).

One of the favorite toys of all animals' was a rubber hoop about twenty inches in diameter, made out of heavy water hose. It was used by the dolphins to swim through its opening with undulating movements of the body. They had to overcome the obstruction of the dorsal fin as well as the spread of the flukes. (Some animals also used it to stimulate their genital regions).

Elvar used hoop in conjunction with his body "bends", What at first appeared to be awkward

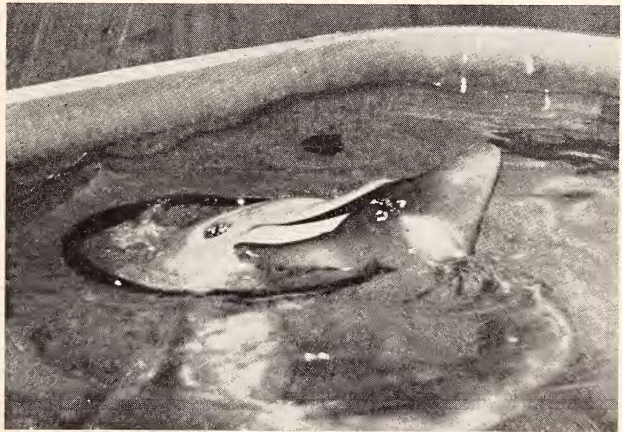


Fig. 2. Elvar curls up into a ring while holding the hoop on his peduncle

bodily contortions, took definite form as Elvar began to execute "tail stands" by lowering himself laterally on his tail (the region between the anal opening and the flukes). Later, after many trials, this posture was alternated with "head stands", whereby Elvar lowered himself laterally on his side in the area of the flipper and thrust his tail straight out of water, sometimes waving his flukes in the air. Or, he allowed his tail to drop in a semi-circle over his head. He apparently enjoyed this form of exercise

greatly, for he repeated the tail and head "stands" time and time again. He often varied these flexures by swimming rapidly around the pool, sending the water surging over the ledge. Sometimes, he flipped on his back and continued swimming in this fashion, then returned to flexures again. In the further development of the "bends", Elvar curled up into a solid ring, whereby he was able to touch the fluketip with his beak, or to place it between the tips of his jaws. At these times he usually carried the hoop on his flukes or on his peduncle (Fig. 2).

Since all his flexures for an unknown reason were executed to the left side, the nearest fluketip the left, was more accessible than the right. He persisted in his efforts until he was able to negotiate his right fluketip with equal ease by controlled muscular

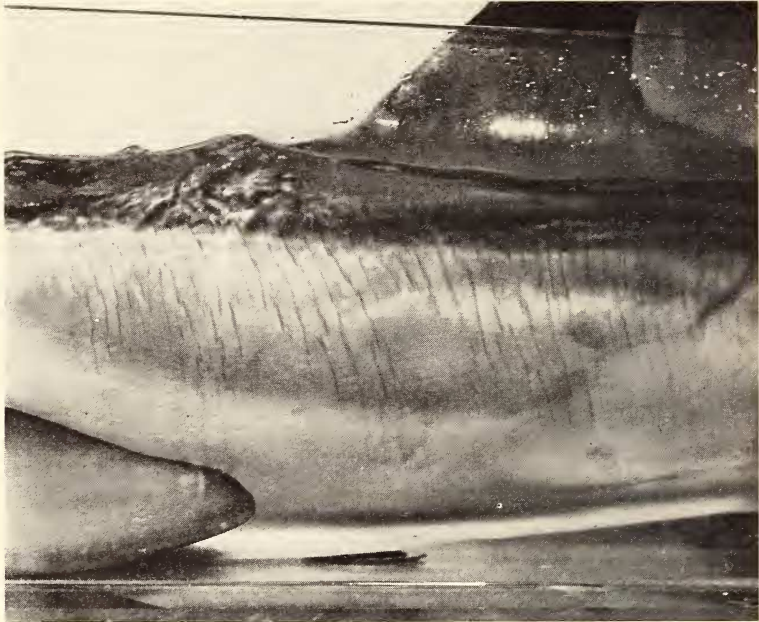


Fig. 3. Deep vertical creases form on Elvar's left lateral surface as a result of bends

action. As a result of his "bends" to the left he has acquired deep vertical permanent creases along his left lateral surface (Fig. 3). Except for a few skin folds along the region of the head, his right side is free of such markings.

In this connection, it might be of interest to point out that Chee Chee, the occupant of the neighboring pool, imitated most of Elvar's actions including flexing of the body. But, even though Chee Chee exercised over a period of months, she never achieved the dexterity and the ease with which Elvar performed his "bends". This, no doubt, was due to her age and her greater body girth and weight. Oddly enough, all her "bends" were made on the side opposite from Elvar's, on the right side, resulting in some permanent creases on her right side.

In order to reinforce the walls of the plexiglass sidearm tanks, it was deemed advisable to brace the tanks through the center with a thickness of polyethylene rope. Although this rope did not hinder his movements in or out of the tank, Elvar soon learned to exert enough driving force with an upright movement of his head (Fig. 4), or with his dorsal fin by bracing himself against the floor of the tank with his flukes (Fig. 5) to cause the rope to break. He broke several successive replacements, until a double strength of nylon roping was substituted for the polyethylene material. This

proved to be a much stronger material and although Elvar was partly successful in breaking one thickness of the rope, he soon gave up further attempts.

Although dolphins have been known to wet humans by employing a slapping movement of the flukes against the surface of water, Elvar early developed the habit of squirting water at the humans by means of his mouth. He was able to send a stream of water accurately, in a forward or sidewise direction, while aiming at a particular person. He was able to span a distance of 15 to 20 feet easily.

When humans tried to dodge him, while he was occupying the plexiglass sidearm, by placing themselves out of his reach in the central area of the tank, the adroitly utilized his dorsal fin by spilling water over the side of the tank with a sudden rolling movement of his body (Fig. 6).

When humans attempted to escape farther, Elvar made use of his flukes by scooping up a large quantity of water with his flukes and by propelling it horizontally through the air in the direction needed. Thus, he was able to throw water at humans in a number of ways when he so wished.

Chee Chee, while imitating most of Elvar's actions, was more gentle, less forceful in relations with humans.

Another dolphin, Sissy, a female estimated to be four years old during the same period of observations was captured on 8 May, 1961. After having shared a pool together with Elvar and Chee Chee for several months, Sissy was moved to another pool, 70 inches long, 42 inches wide, and 18 inches deep. This pool was situated on a lower level of the same building.

She quickly adjusted herself to the new environment, feeding normally and swimming about from time to time. She not only was able to circle the new pool rapidly, whereby her flukes flipped out of water while rounding the corners but she was also able to perform perfectly executed figure "8's" several times in succession. The latter required considerable agility of body and synchronization of body movements.

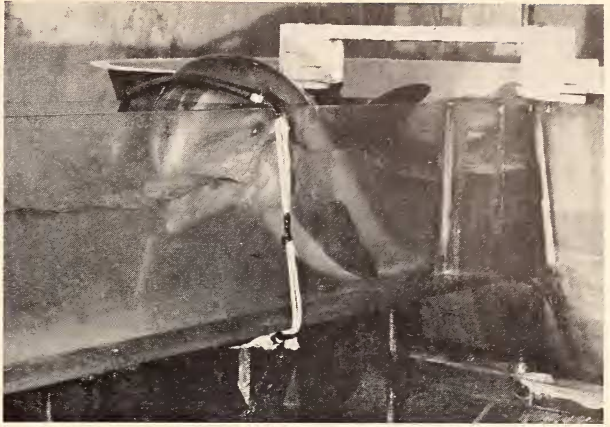


Fig. 4. Elvar slams his head forcefully against the rope, trying to break it

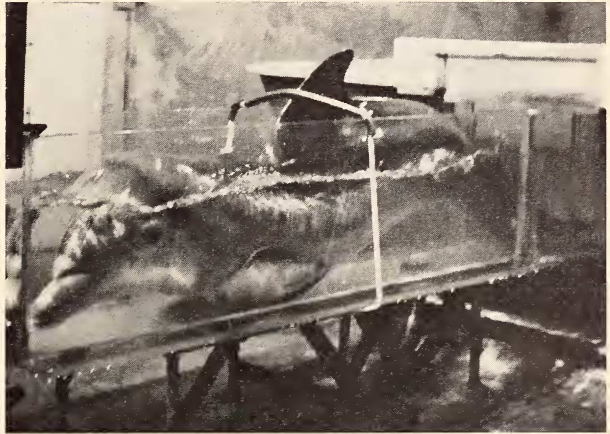


Fig. 5. Elvar presses his dorsal fin against the rope in an attempt to break it. Note positioning of the tail



Fig. 6. With a rolling movement of his body Elvar splashes water by means of his dorsal fin



Fig. 7. Sissy rests her jaw on the edge of pool

Simultaneously, Sissy initiated attempts to raise herself upon the ledge of the pool. She accomplished this by propelling herself forward with a beat of her flukes and by resting her lower jaw on the edge of the pool. Whenever she succeeded in gaining a good hold she remained in this position from several seconds to nearly a minute (Fig. 7), only to repeat these attempts over and over again.

At times, she alternated this exercise by raising her head and tail vertically out of water, while resting on her flippers or her underside (Fig. 8). She paid little attention to the toys proffered to her, but instead accelerated her gymnastic activity.

Since the ledge of the pool was very slippery and her perch rather insecure, causing

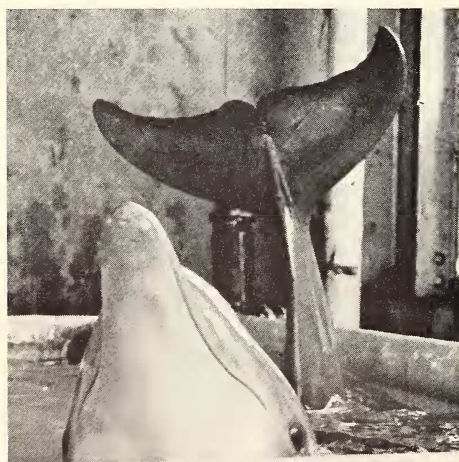


Fig. 8. Sissy raises her head and tail dorsally out of water

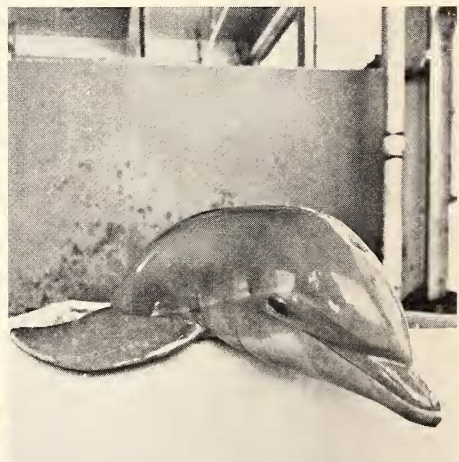


Fig. 9. Sissy flips one flipper over the edge of pool

her to slip into the pool, Sissy next attempted to flip her flipper over the ledge of the pool to strengthen her hold there. After many trials, she finally succeeded in performing this feat almost effortlessly (Fig. 9). However, this position was lopsided and resulted in considerable stress on one shoulder. To gain a better balance, Sissy next proceeded in her attempts to extend her second flipper over the ledge on the same side of the pool. This was, of course, anatomically very difficult if not impossible of achievement. After many trials, Sissy resolved the problem by utilizing the corner of the pool, whereby she flipped her right flipper over the long side of the pool and with a stroke of her tail advanced herself in a glide toward the short side. She then flipped her left flipper over the ledge. In this position (Fig. 10), she remained stationary for as long as 2 to 3 minutes quietly observing the surroundings. She eased herself into the pool by first withdrawing the left flipper, then dropped into the water.

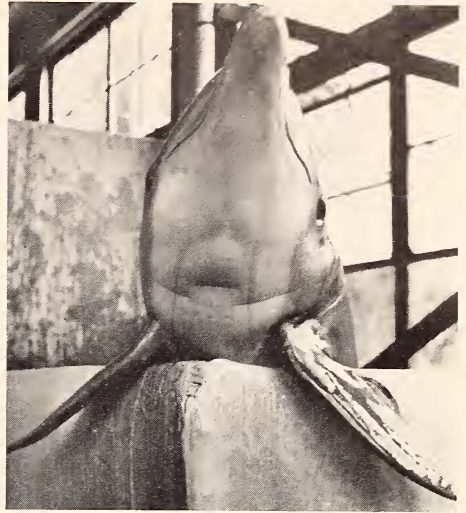


Fig. 10. Sissy uses both flippers in a corner of the pool.

However, her drive was so persistent and so forceful that it was thought best to erect an ascending apron all around her pool for fear that in her enthusiasm she might topple over the side of the pool, which was set up about two feet above the ground. With this obstruction in the way she was no longer able to gain a flipperhold on either side of the pool, and no longer able to exercise in the accustomed manner. Nonetheless, she did partly overcome this obstacle by bracing herself across the narrow part of the pool, and yet remained within safe bounds of the pool (Fig. 11).



Fig. 11. Sissy braces herself across the pool. Note the ascending apron around the pool.

Since this form of self-amusement and exercise was eliminated, Sissy resorted to the habit of rocking herself in the water for protracted periods, by rhythmically undulating her body. When sufficient backlash of water was gained, she relaxed and floated riding the waves, as the water rushed back and forth from one end of the pool to the other and over the ledge. When very energetic, she reduced the pool of half its contents in a matter of seconds. Rocking in the water has also been observed and described by KELLOGG (1961). Subsequently, she was flown in a special

water filled caring box to St. Thomas, U. S. Virgin Islands laboratory of the Communication Research Institute, where she resides in a large outdoor pool with other dolphins. She is so human-oriented, that she deserts her playmates the instant she detects the presence of a human near the pool.

Discussion

The extreme flexibility of the *Tursiops*' body as shown in the case of Elvar und Sissy demonstrates the fact that considerable range of plasticity may be achieved with constant exercise over comparatively short periods of time. That these flexures were made possible at all, is due in great measure to the perseverance and patience with which both animals pursued their exercises, advancing a step at a time, then proceeding further in the development of their individual techniques.

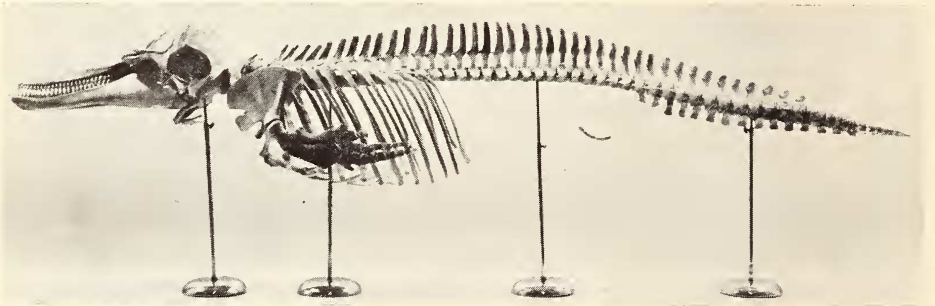


Fig. 12. Skeleton of a juvenile *Tursiops truncatus*. Prepared by CHARLES B. SEVERN, Communication Research Institute

Even so, the degree of plasticity gained would hardly have been possible without the anatomical basis present. The *Tursiops*' vertebral column contains about 63 to 64 vertebrae, which is divided as follows (TOMLIN, 1957), (Fig. 12):

Cervical vertebrae	7	Lumbar vertebrae	17
Thoracic vertebrae	12-14	Caudal vertebrae	26-27

While the number of cervical and thoracic vertebrae is almost the same as in land mammals, the lumbar and caudal regions are greatly elongated. "This increase in number of the vertebrae causes an increase in mobility and elasticity of the vertebral column because the amount of cartilage (intervertebral discs) is greatly increased" (SLIJPER, 1961).

Another factor entering into consideration of mobility is the powerful musculature enveloping the cetacean body. "The musculature is characterized by the fact that the muscles of the neck, the trunk, and the tail are completely fused. Consequently, each of the three big epaxial muscular systems is represented by one single unit ranging from the occiput to the tip of the tail" (SLIJPER, 1961). Obviously, this peculiar structure also contributed to the plasticity of body, and enabled the animals to extend their physical capacities in new ways.

Of the two animals, Sissy was prone to perform especially in the presence of humans. Whenever humans entered her room, she accelerated the frequency of her successive climbs and, perched on the ledge of the pool, fixed her gaze at the humans nearby. She remained so poised, practically immobile and silent, for 2-3 minutes at a time. Whether this Pinniped-like posture was an expression of self-contentment over

her own skill, or whether the animal sought some sort of reward or praise for her performance in the presence of humans, it is difficult to state.

There is little doubt, though, that the animals engaged in various gymnastics as a matter of individual inclination and pastime. The fact that they developed these diversions by themselves, is of special interest.

Although living in close proximity, neither Elvar nor Chee Chee was observed to attempt a leap over the partition into the adjoining pool. This looked as if it could have been accomplished by either animal with ease, as the barrier extended above the water about 8 to 10 inches. Frequently, Elvar raised himself above the partition and while leaning against it he could have slid into Chee Chee's pool almost effortlessly, and yet he failed to bring this about.

This strange failure to leap or to slide over the barrier is not unlike the behavior of small trapped cetaceans which, when encircled in a net, failed to leap or to swim over the float line of the net to freedom (TOMILIN, 1957).

The above mentioned failures to overcome obstacles or hindrances by leaping over them, might be traced to the *Tursiops*' natural habit of scanning the object visually or acoustically, and then of bypassing it or by swimming underneath it. The submarine sonar which will not work in the air, may also be an important factor in the consideration of this problem.

Another habit observed in captive *Tursiops* was the raising of the head and tail dorsally, simultaneously or separately, when the level of water in the pool was lowered.

A somewhat similar behavior was observed by this writer on the occasion of a stranding of a school of 46 pilot whales, *Globicephala macrorhyncha* (Gray), at St. Augustine Beach, Florida, on October 7, 1948. Lying on their sides, in shallow water, some animals raised their tails high in the air repeatedly, although they were barely able to lift their heads.

The similarity of behavior in both instances is rather striking. It is not unlikely that these movements of head and tail are related to the respiratory reflex.

Acknowledgments

During the course of this research support was received from grants from National Institute of Neurological Diseases and Blindness, N. I. H.; from the Air Force Office of Scientific Research; Office of Naval Research; the National Science Foundation; the Coyle Foundation and private contributors.

The author wishes to thank the Director, Dr. JOHN C. LILLY for his aid and encouragement.

Summary

1. Unusual body flexions were developed by captive bottle-nosed dolphins, *Tursiops truncatus*, in the laboratory tanks.
2. Some of the exercises consisted of extreme lateral body bends, which culminated in arching of the entire body into a circle.
3. Other body movements were employed by utilizing head, tail, dorsal fin, or flippers to effect certain postures or consequences.
4. All of these exercises were developed spontaneously by the animals themselves.
5. It appeared to the observer as though the animals engaged in various exercises for their amusement.

Zusammenfassung

1. Durch gefangene Tümler, *Tursiops truncatus*, wurden in Laboratorium-Tanks ungewöhnliche Körperbiegungen ausgeführt.
2. Einiger dieser Übungen bestanden in extremen seitlichen Rumpfbiegungen, die darin gipfelten, daß der ganze Körper einen Kreis bildete.

3. Bei anderen Körperbewegungen werden Kopf, Schwanz, Rücken- und Brustflossen zur Erreichung bestimmter Stellungen oder Bewegungsabläufe benutzt.
4. All diese Übungen wurden von den Tieren selbst spontan entwickelt.
5. Der Beobachter glaubt, daß die Tiere die verschiedenen Übungen zu ihrem Vergnügen ausführen.

Literature

- KELLOGG, W. N. (1961): Porpoises and Sonar; The University of Chicago Press, 177. pp.
 LILLY, J. C. (1961): Man and Dolphin; Doubleday, Garden City, N. Y., 312 pp.
 LILLY, J. C. and A. M. MILLER (1961): Vocal exchanges between dolphins; Science, 134 (3434): 1873—1876.
 SLIJPER, E. J. (1961): Locomotion and locomotory organs in whales and dolphins; Symp. Zool. Soc. London, Nr. 5: 77—94 pp.
 TOMILIN, A. G. (1957): Kitoobraznye (Cetacea); Zveri SSSR i prilozhashchikh stran (Mammals of USSR and adjacent countries); Moskva, Akad. Nauk, 2: 756 pp.
 All photographs by F. S. ESSAPIAN.

Anschrift des Verfassers: FRANK S. ESSAPIAN, P. O. Box 3251, Miami/Florida 33101, USA

Zur Verbreitung des „Sansibar-Leoparden“, *Panthera pardus adersi* Pocock, 1932

VON L. J. DOBRORUKA

Aus dem Zoologischen Garten Prag (Dir. Dr. Z. Veselovsky)

Eingang des Ms. 18. 3. 1964

Im Jahre 1932 (Abstr. Proc. Zool. Soc. London 347:33) hat POCOCK einen Leoparden aus Chuaka, Sansibar, als eine neue Subspecies unter dem Namen *Panthera pardus adersi* beschrieben. Diese Subspecies sollte nur auf der Insel Sansibar leben, während auf dem anliegenden Festlande die Subspecies *suabelica* vorkommen sollte. *P. p. adersi* unterscheidet sich von *P. p. suabelica* hauptsächlich durch das Fleckenmuster, das aus kleinen, fast völlig in Tupfen zerfallenen Rosetten gebildet ist. Rosettenkerne sind nicht dunkler gefärbt als die Grundfarbe, die etwas heller (fahler) sein kann als bei *suabelica*. Nach POCOCK's Angaben soll der Schwanz kürzer sein als bei der Festland-Rasse; diesem Autor waren aber nur zwei Felle bekannt.

Schon MATSCHIE (1907, Liste der von Herrn C. G. SCHILLINGS gesammelten Säugtier-Arten, in C. G. SCHILLINGS „Mit Blitzlicht und Büchse“, Voigtländer Verl., Leipzig 1907), unterscheidet in Ostafrika zwei Leoparden — den „kleinfleckigen Suaheli-Leopard“, welchen er *Leopardus suabelicus* nennt, und den „großfleckigen Massai-Leopard“, *Leopardus spec.* Da aber die Terra typica von *Felis pardus suabelicus* NEUMANN 1900 am Manyara-See liegt (Terra typica resticta nach HOLLISTER 1918), gehört dieser Name der großfleckigen Massaiform an. Eine schöne Abbildung des „Ostafrikanischen Küstenleoparden“, also der kleinfleckigen Form, finden wir bei HECK (1899, Lebende Bilder aus dem Reiche der Tiere, Berlin), die auch in meiner Arbeit (DOBRORUKA 1962, Zs. f. Säugetierkunde 27,4:204—211) abgedruckt ist. In der genannten Arbeit reihte ich noch provisorisch den Küstenleopard zu der Subspezies *suabelica* ein. Im Zoologischen Museum in Berlin sind zwei Felle von solchen Leoparden aufbewahrt, die ich näher untersuchen konnte: aus Pugu in den Uluguru-Bergen, Bez.